WDNS About Density Altitude

Capt Johnson
NATOPS Officer

DA Defined

- Density altitude is the pressure altitude corrected for temperature and humidity deviations from the standard atmosphere.

- Air density affects the aerodynamic forces on the rotor blades and the burning of fuel in the engine, affecting both power required and power available.

Temperature

- High free air temperature results in increased inlet air temperature, which has an adverse effect on power output of gas turbine engines. High FAT may result in the engine being TOT rather than transmission or Ng limited.

- At a constant pressure altitude, a 10 degree C increase in FAT will decrease engine output power available by approximately seven percent; therefore, helicopter performance could decrease because of high ambient temperature.

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Humidity

The effect of humidity on gas turbine engines is negligible; however, since humidity does affect air density, a noticeable effect upon rotor system performance will occur. For each 10 percent increment of humidity, density altitude sho increased by 100 feet prior to calculation of any performance parameter.

Note :

Density altitude, as computed from Figure 23-2, is not corrected for humidity.

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Two ways to calculate DA:

1. $$[\text{OAT @ ALT (°C.)} - \text{STAND TEMP @ ALT}] \times 120 \text{ ft.} + \frac{(RH)}{10\%} \times 100 + PA = DA$$

or

2. Chart located in NATOPS/PCL

DA Calculation

$$[\text{OAT @ ALT (°C.)} - \text{STAND TEMP @ ALT}] \times 120 \text{ ft.} + \frac{(RH)}{10\%} \times 100 + PA = DA$$

STAND TEMP - 15° C. at sea level and cools 2° per 1000 ft.

RH - Relative Humidity
PA - Pressure Altitude

Example:

PA = 4000 ft.
RH = 70%
OAT = 17° C.

First find the standard temperature at altitude.

15° - (4000 x 2°/1000 = 7° C.

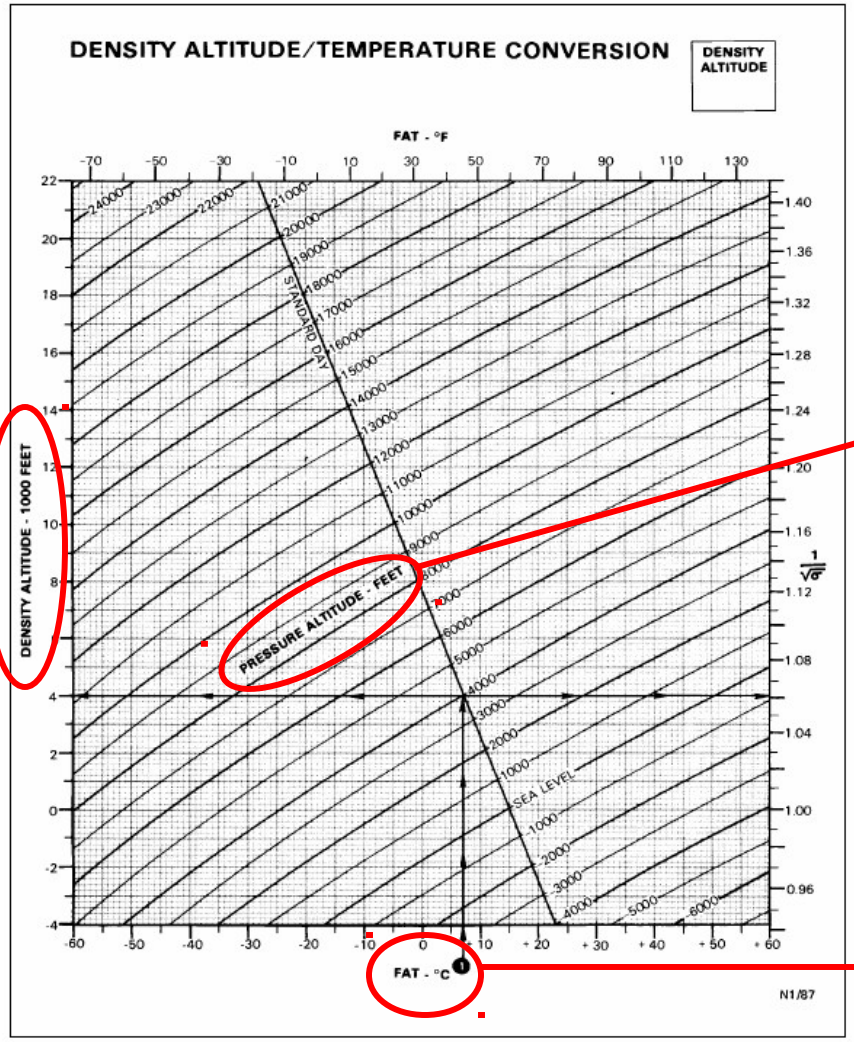
$$DA = [17° C. - 7° C.] \ 120 \text{ ft.} + \left(\frac{70\%}{10\%}\right) 100 + 4000$$

= 1200 ft. + 700 ft. + 4000 ft.

= 5900 ft.

Aerodynamics

DA Calculation



DA

PA

FAT

Figure 23-2. Density Altitude/Temperature Conversion Chart (Sheet 2 of 2)

RWOP

- Practice full auto’s not authorized above 45 gallons
- Simulated engine failures at altitude shall not be conducted at gross weights above 2900 lbs when the DA exceeds 1800 ft
- Practice autorotation’s shall not be conducted when winds are less than 5 kts and the density altitude exceeds 2500 ft. (Applies to both full and power recovery autos)
- Cut guns and power recovery auto’s shall not be conducted when gross weight exceeds 2900 lbs.

Implications of high DA operations

- Power required exceeds power available
- Loss of tail rotor effectiveness
- Rotor blade stall

Power Required Exceeds Power Available

Indications:

Uncommanded descent with torque at maximum allowed.

Rotor droop.

Loss of tail rotor effectiveness.

Procedures:

*1. Collective — Adjust as required to maintain N_r in operating range.

*2. RPM switch — Full increase.

*3. Airspeed — Increase/decrease to 50 KIAS (minimum power required airspeed).

*4. Angle of bank — Level wings.

*5. Jettison — As required.

If impact is imminent:

*6. Level the aircraft to conform to terrain.

*7. Cushion the landing.

Loss of Tail Rotor Effectiveness

Procedures:

*1. Pedals — Maintain full left pedal.

*2. Collective — Reduce (as altitude permits).

*3. Cyclic — Forward to increase airspeed.

If spin cannot be stopped:

*4. Autorotative landing — Execute.

Rotor Blade Stall

Indications:

Progressively increasing two-per-revolution vibrations.

Loss of longitudinal control and severe feedback in the cyclic.

Violent vertical nose oscillations independent of cyclic position.

Procedures:

Recovery may be accomplished by one or a combination of the following:

*1. Severity of maneuver — Decrease.

*2. Collective pitch — Decrease.

*3. Altitude — Descend.

*4. Rotor RPM — Increase.

CAUTION

Entry into severe blade stall can result in structural damage to the helicopter.

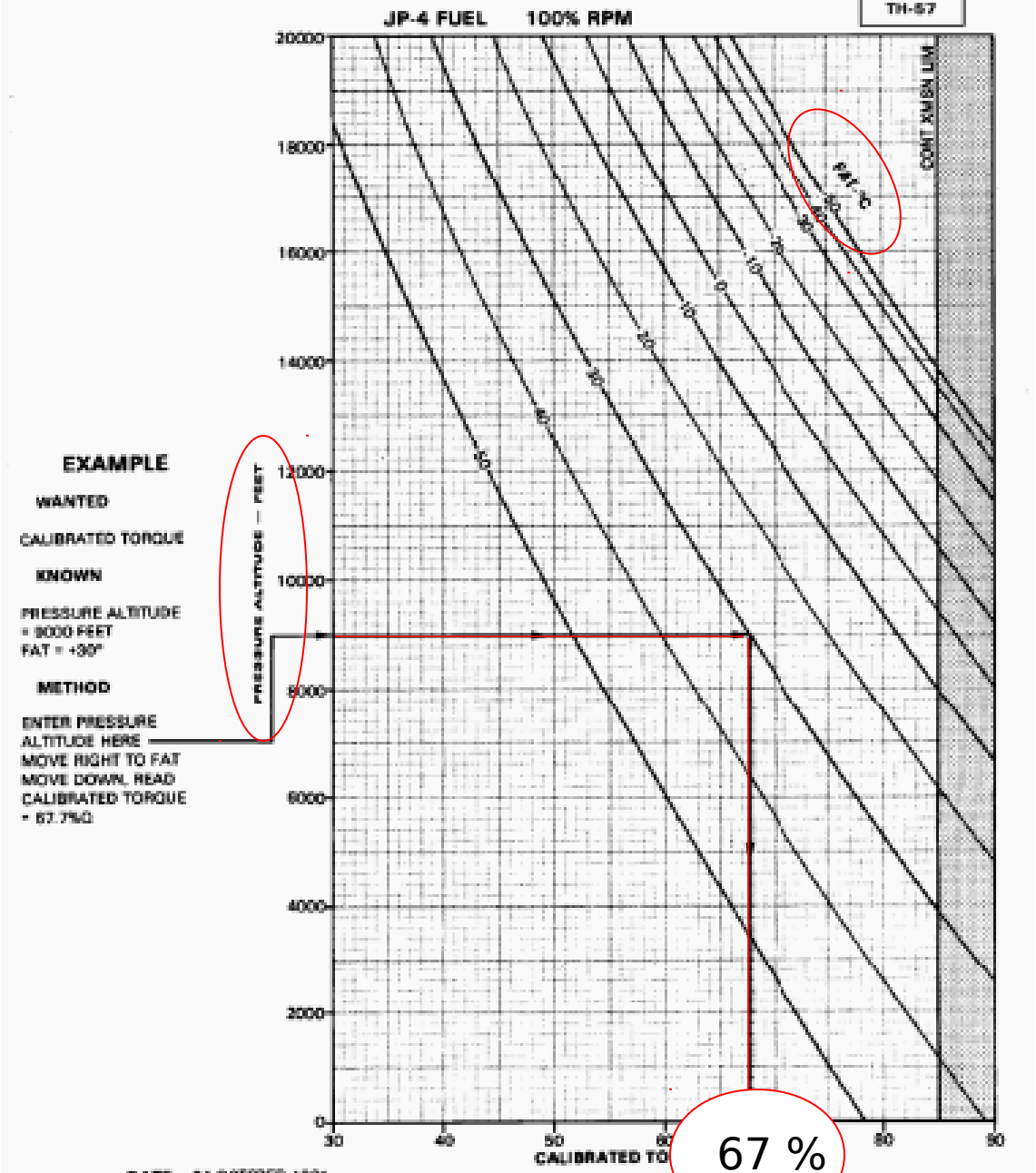
Tactical Implications

Afghanistan

- Elevation:
  - Plains about 3000 feet MSL
  - Mountain range >20,000 feet MSL
- Temperature:
  - Average Temp in Kabul exceeds 30 degrees C in summer months

TORQUE AVAILABLE (CONTINUOUS OPERATION)

TORQUE AVAILABLE TH-57



EXAMPLE

WANTED

CALIBRATED TORQUE

KNOWN

PRESSURE ALTITUDE = 9000 FEET
FAT = +30°

METHOD

ENTER PRESSURE ALTITUDE HERE
MOVE RIGHT TO FAT
MOVE DOWN, READ CALIBRATED TORQUE = 67.7%Q

DATE: 24 OCTOBER 1991
DATA BASIS: DERIVED FROM FLIGHT TEST OF SIMILAR TYPE AIRCRA

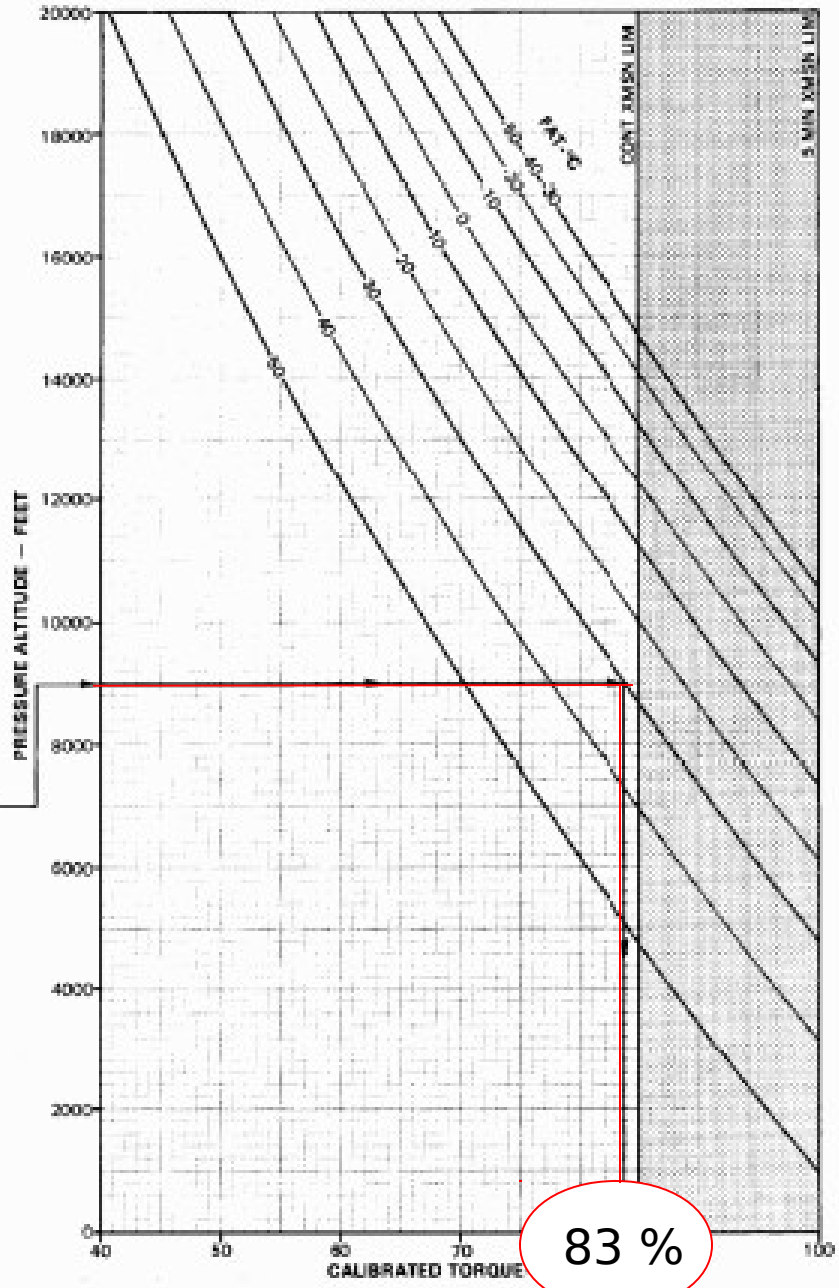
N1/87

MAXIMUM TORQUE AVAILABLE

(5 MINUTE OPERATION)

JP-4 FUEL 100% RPM

MAXIMUM TORQUE TH-67



EXAMPLE

WANTED

CALIBRATED TORQUE

KNOWN

PRESSURE ALTITUDE
= 9000 FEET
FAT = +30°

METHOD

ENTER PRESSURE ALTITUDE HERE
MOVE RIGHT TO FAT
MOVE DOWN, READ CALIBRATED TORQUE
= 83.5%Q

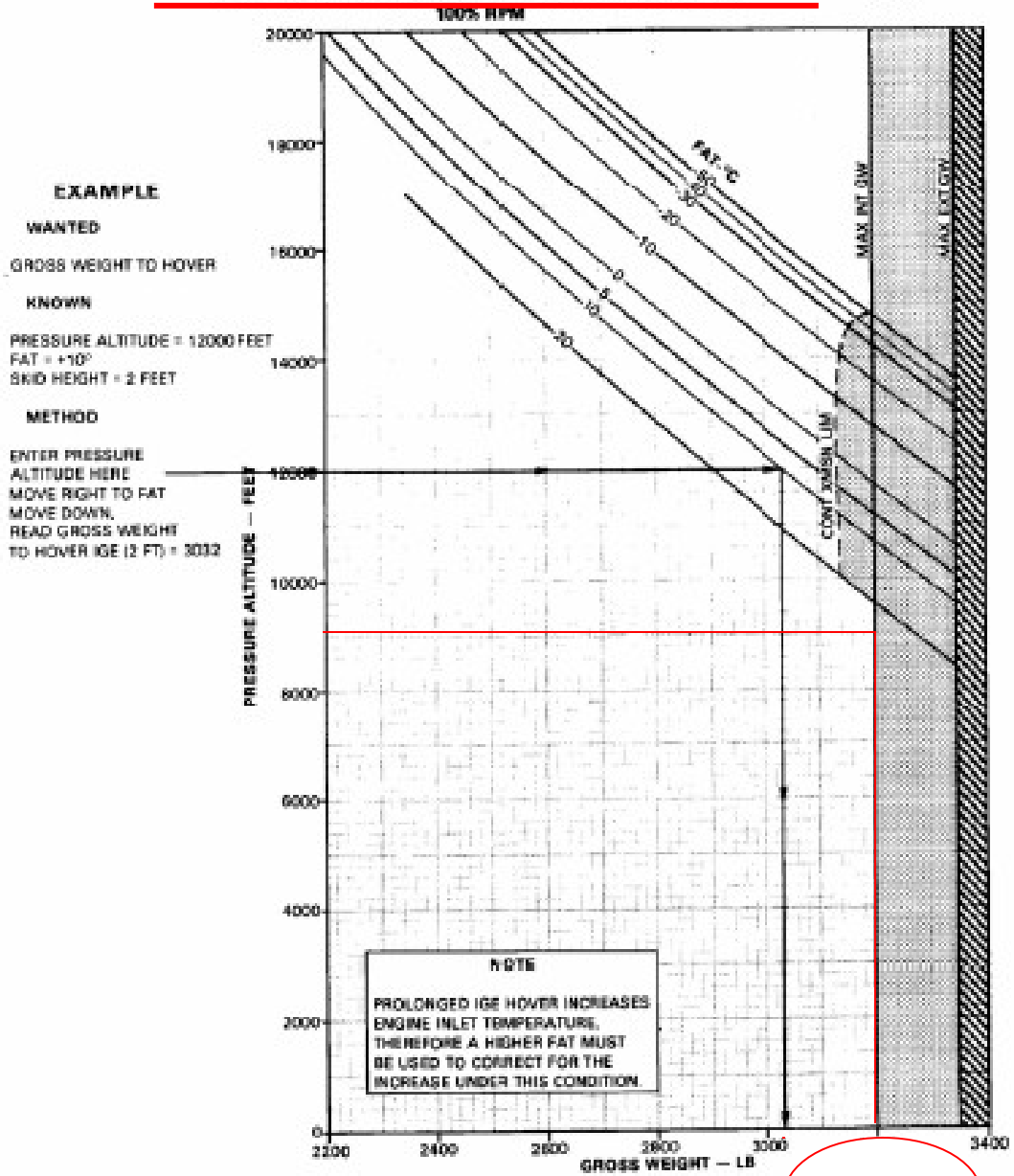
DATE: 24 OCTOBER 1981
DATA BASIS: DERIVED FROM FLIGHT TEST OF SIMILAR TYPE AIRCRAFT

M1/67

HOVER — IGE (2 FOOT SKID HEIGHT)

MAXIMUM TORQUE AVAILABLE (5-MINUTE OPERATION)

HOVER
TH-57



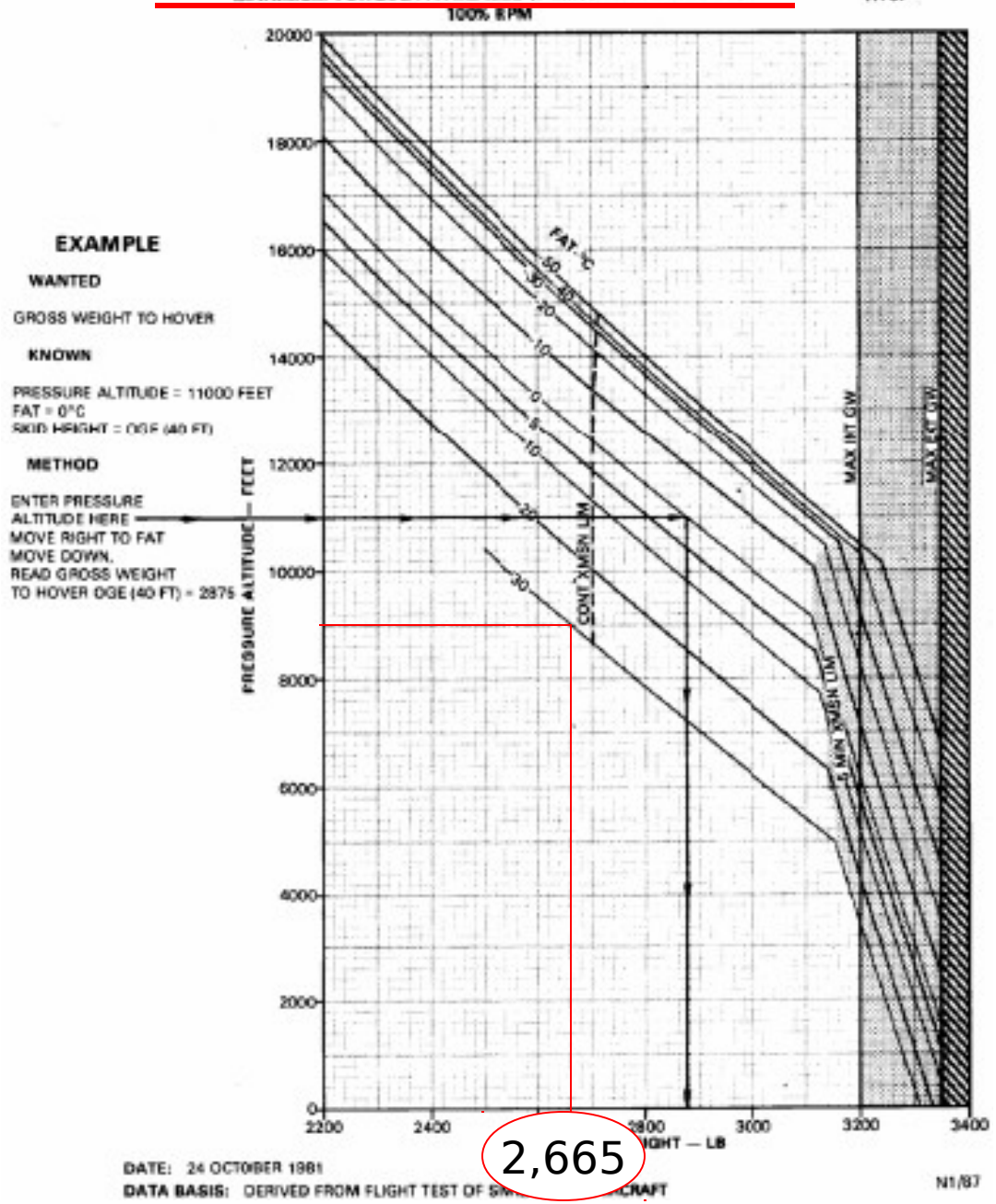
DATE: 24 OCTOBER 1981
DATA BASIS: DERIVED FROM FLIGHT TEST OF SIMILAR TYPE AIRCRAFT

3,200

HOVER — OGE (40 FOOT SKID HEIGHT)

MAXIMUM TORQUE AVAILABLE (5-MINUTE OPERATION)

HOVER
TH-57



EXAMPLE

WANTED

GROSS WEIGHT TO HOVER

KNOWN

PRESSURE ALTITUDE = 11000 FEET
FAT = 0°C
SKID HEIGHT = OGE (40 FT)

METHOD

ENTER PRESSURE ALTITUDE HERE
MOVE RIGHT TO FAT
MOVE DOWN,
READ GROSS WEIGHT TO HOVER OGE (40 FT) = 2875

2,665

DATE: 24 OCTOBER 1981
DATA BASIS: DERIVED FROM FLIGHT TEST OF SK… …CRAFT

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